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We hereby declare that w have checked this thesis and in our opinion, this thesis is adequate in terms of scope and quality for the award of the degree of Bachelor of Engineering (Hons) in Mechatronics Engineering.

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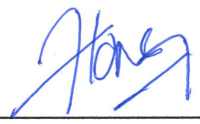
I hereby declare that the work in this thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at Universiti Malaysia Pahang or any other institutions.



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DEVELOPMENT OF EL[illegible]ORY FOR DETECTING ASTHMA

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ABSTRAK

Dalam tesis ini, prototaip peranti pengukuran karbon dioksida (CO_2) telah direka untuk mengesan dan memantau pesakit asma. Pada msa kini, capnogram telah diggunakan dengan secara luas dalam memantau asma serta perkhidmatan perubatan. Walau bagaimanapun, harga capnogram dalam pasaran amat mahal terutama begi pesakit kolongan berpendapatan rendah. Untuk menangi masalah tersebut, peranti kos rendah ini dihasilkan untuk mengesan dan memantau asma. Oleh itu, peranti ini dapa dimiliki ramai termasuk kolongan pendapatan rendah. Tambahan pula, spirometer dan peak flow meter terkenal dalam pemantau asma. Malanynya, kedua kedua peranti menpunyai had masing masing. Spirometer mempunyai prosedur yang complex, pesakit menghadapi kesukaran dalam melaksanakan kriteria yang ditetapkan serta peranti ini sesuai bagi pesakit umur 6 dan atas sahaja. Sementara itu, peak flow meter akan menyebabkan dada pesakit mengalami kesakitan kerana peranti itu memerlukan pesakit menghembus nafas pada kadar maksimum. Untuk mengatasi batasan-batasan tersebut, eleltronik kit diprototype bagi mudah digguna serta sesuai bagi semua pesakit walaupuun kecil daripada umur 6. Elektronik kit ini terdiri daripada MH-Z14A CO_2 sensor untuk mengesan kepekatan karbon dioxida yang dihembus dari pengguna, Arduino untuk menproses data dari sensor tersebut, TFT Display digguna untuk mempamerkan keputusan manakala Bluetooth modul HC-06 digguna untuk berinteraksi dengan komputer bagi analisis selanjutnya. Prototaip ini diuji dengan 3 pungguna asma serta biasa. Hasil kajian menunjuk bahawa pungguna asma mempunyai corak yang berbeza berbanding dengan pengguna biasa. Kesimpulannnya, peranti ini telah berjaya membezakan perbezaan antara pengguna biasa seta asma. Oleh itu, peranti ini sesuai untuk memantau atau mengesan asma.

ABSTRACT

In this paper, a prototype of a carbon dioxide (CO_2) measurement device has designed to detect and monitor asthma patient. Nowadays, capnogram is widely uses in monitoring asthma and medical services. However, capnogram is costly and unaffordable for patient especially those in a low class family. Therefore, this low cost device is produced to detect and monitor the severity of asthma, this device can be owned by every class of family. Furthermore, spirometer and peak flow meter is well known in monitoring asthma. Unfortunately, these two devices have their own limitations as spirometer has complex procedures as the patient face difficulties on performing multiple criteria when using it and only suitable for age range above 6 years old. Meanwhile, flow meter will caused patient to have chest pain as they needed maximum effort to blow in the device. To overcome these limitations, this prototype electronic kit is easy to use and suitable for all range of patients. This prototype electronic kit consists of MH-Z14A CO_2 sensor to detect the concentration of CO_2 from exhaled air from user, Arduino microcontroller to process the data, TFT Display shield for data presentation and HC-06 Bluetooth module to communicate with PC for further analysis. This device was tested with 3 asthmatic and 3 normal users. The results showed that asthmatic user has a different graph pattern compared with normal user. This device has successfully distinguished the difference between asthmatic and normal user; therefore it is suitable for asthma monitoring.

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LIST OF SYMBOLS

α	Alpha angle
β	Beta angle
m	Gradient
x_1	Previous time
x_2	Time
y_1	Previous concentration of carbon dioxide
y_2	Concentration of carbon dioxide

LIST OF ABBREVIATIONS

CATIA	Computer-aided three-dimensional interactive application
CO	Carbon Oxide
CO2	Carbon Dioxide
GUI	Graphical User Interface
IR	Infrared transceiver
mmHg	millimetre of mercury
MOS	Metal Oxide Semiconductor
NH3	Ammonia
NO	Amperometric nitric gas oxide sensor
PC	Personal computer
PEF	Peak expiratory flow
Ppm	Parts per million
RSACC	Adaptive Respiratory Spectrum Correlation Coefficient
UAK	User Awareness Kit
UART	Universal Asynchronous Receiver/Transmitter
UMP	Universiti Malaysia Pahang
USB	Universal Serial Bus

CHAPTER 1

INTRODUCTION

1.1 Introduction

Asthma is a chronic disease involved the airways in the lungs and it causes difficulty in breathing due to respiratory condition marked by spasms in the bronchi of the lungs. McPhee et al. (2010) review that asthma exacerbation is a reduction in expiratory flow which is caused by many asthma triggers and the main triggers which will lead to the symptoms of respiratory diseases included viral infection, air pollutions, exercise, cockroach allergen and dust mists.

Asthma, a disease which mainly in full grown adults but as time goes by, this disease has been rapidly spread in younger children based on Shikalgar et al. (2016). For the pass decades, countless of research has been carried out to solve this problem. Chatzimichail et al. (2011) review that it is still remain a challenge for the clinical doctor to diagnoses in children younger than five years old as they will often misdiagnoses as having common-cold, bronchiolitis or pneumonia. Namazova-Baranova et al. (2015) reported that it is exceptionally decisive for remote monitoring of various parameters not only for infants and preschool children but also school age patients and adolescents.

So far, asthma still cannot be cure. However, it can be controlled by monitoring regularly and it can be achieved through using appropriate pharmacological interventions to reduce the risk. Benjamin Franklin once said:" An ounce of prevention is worth a pound of cure". Therefore, a proper diagnosis and monitoring are crucial as the symptoms are different from patient to patient. In this twenty century, technology plays a curial role in helping asthmatic to manage their symptoms. For example, based on Seto et al. (2009) review that home telemonitoring is an alternative approach to

asthma management. Home telemonitoring are monitoring an asthmatic by having clinical and physiologic data transmitted to healthcare provided.

At present, the method commonly used for monitoring and control this disease is using peak flow meter and spirometer. These devices are very useful in monitoring asthma; unfortunately, they have their limitations. Based on Zuleika et al. (2014) reviews that when patient using peak flow meter, they needed maximum effort to blow in the device and as a result it will cause chest pain. Also, spirometer suitable age range is above six years old, so for those below six years old are difficult to fulfill the end-test-result as they face difficulties on performing multiple criteria to meet the requirement set by the spirometer based on Richards et al. (2006) research.

A new method is introduced to monitor the severity of asthma without harming the patients and suitable for all range of patients. Non-invasive continuous analysis of the concentration of carbon dioxide in respiratory cycle is called capnography. This new method uses infrared technology to determine the concentration of the CO_2. Based on the capnogram, asthmatic patient and normal patient can be easily differentiated. Figure below shows a comparison between normal and abnormal capnogram.

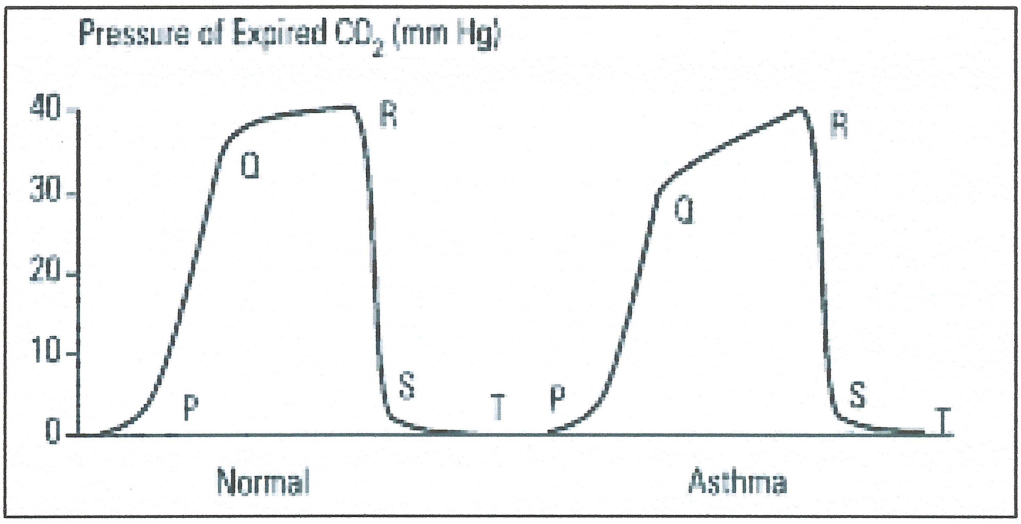

Figure 1.1 Capnogram between normal subject and Asthma subject
Source: Yaron et al (1996)

In this project, a new portable electronic kit is designed to monitor and detect asthma. The main component in this electronic kit included low cost MH-Z14A CO2 sensor, Arduino microcontroller, TFT LCD shield and HC-06 Bluetooth Module. The purpose of MH-Z14A CO2 sensor is to detect the concentration of the exhaled CO2 by

the subject. Then, the information or data from this sensor will be transfer to Arduino microcontroller. Then, Arduino microcontroller will receive and process the data before sending them to data-presentation element, TFT LCD shield. Data from CO2 sensor will be display on TFT LCD shield. In order to display the data more clearly for the user, data will also sent to PC using HC-06 Bluetooth Module.

1.2 Problem Statement

As the developed country increases, asthma morbidity and mortality increases too. Our country, Malaysia is rapidly becoming industrialized, is probably similarly saddled, especially with increased morbidity. Unfortunately, asthma patient management on asthma is still poor as they believed if they took quick-relief medication three times a week, their condition was well controlled. Honestly, their thinking is totally wrong because asthma have to be managed and controlled. Therefore, this portable electronic kit is developed to detect and control this disease. By having this device, patient can always monitor this disease. This portable electronic kit is small and portable, so it is easy to carry and move from place to place. Next, this portable electronic kit is also easy to operate and it does not need to follow any difficult procedures. Thus, it is easy to work by anyone at anywhere.

Secondly, this portable electronic kit has overcome some limitation of the asthma devices such as spirometer and peak flow meter. By comparing with spirometer, this electronic kit comprised any age range of patients instead of suitable for only age range six years old and above. Likewise, this device needs not to blow in with maximum effort which cost chest pain at the end by comparing to the peak flow meter. The main reason is that this device used MH-Z14A CO_2 sensor for exhaled of concentration CO_2 detection, which is suitable for every patient either below six years old or above six years old.

Last but not least, capnogram are used in this portable electronic kit to detect and monitor the severity of asthma. Unfortunately, capnogram in market are costly and it is not unaffordable for patients. To overcome this problem, this portable electronic kit used low cost CO_2 sensor to produce a continuous monitoring based on the CO_2 concentration of the patient which is same concept as the capnogram that can found in

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